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ABSTRACT

This study examined the effects of color on information processing strategies of internal and external locus of control learners. Specific objectives were to: (1) examine the instructional effectiveness of two types of visualized instruction in facilitating achievement for students with different learning styles; (2) determine whether an interaction exists between types of learning style and instructional treatment; and (3) determine whether specific instructional treatments were equally effective in facilitating achievement for students with different learning styles. Participants were 107 college students who were classified as external, neutral, or internal locus of control based on their scores on the Rotter Internal-External Locus of Control Scale. Students in the first treatment received an instructional booklet containing directions, prose, and visuals in black and white; students in the second treatment received identical prose instructions and visuals, but their visuals were color-coded. The instructional content related to the anatomy and functions of the human heart. Students were administered drawing, identification, terminology, and comprehension tests. Results indicated that students who received the color-coded treatment scored significantly higher on the identification, drawing, and overall assessments. An outline of the color coding scheme and a table of means and standard deviations for all comparisons are included. (DLS)

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Effect of Color-coding on Locus of Control

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Introduction

As a psychological construct, locus of control describes a condition when people enter into a situation with certain expectancies regarding the probable outcome of their behavior. Expectancy and reinforcement are therefore brought together in a working construct. A determinate within this framework is the degree to which a person feels that they possess (internal control) or lack (external control) power over what happens to them (Rotter, 1966). The use of visuals in instructional materials offers potential for subjects to control their immediate learning environment by selecting or attending to certain visual aspects within a visual.

Research has shown that color-coding instructional materials helps learners organize or categorize information into useful patterns which learners interpret and adjust to their environment. Color-coding may be considered a strategy with which students enhance or sharpen essential message characteristics by providing structures for the interpretation of new information (Dwyer, 1978) If visualization and the use of color-coding provides reinforcement to learners (particularly those of high or external locus of control), color coded materials may be a positive factor in attempts of learners to control their visual learning environment. The purpose of this study will be to examine the effects that color (b/w and color) has on the information processing strategies of the internal and external locus of controlled learners. It is the primary hypothesis of this study that the color coding will significantly improve the students identified as being external locus of control. It was anticipated that the color-coding of concepts and processes would help "externals" recognize and encode imprint concepts and processes leading to greater understanding of the information presented and subsequent achievements.

Literature Review

Locus of control has been defined as a form of self-appraisal related to the degree to which individuals view themselves as having some causal role in determining specific events. Rotter's (1966) Internal-External Locus of Control Scale separates individuals into two perceptual groups (a) internals being individuals who perceive their behavior as being directly related to outcomes, and internals who perceive outcomes as being dictated by chance, luck or circumstances outside of their control (Rotter, 1966; Joe,1971). Hersh and Scheibe (1967) and Gozali et. al. (1973) found the reliability of the Internal-External Locus of Control Scale to range from 0.70 to 0.80.

Observations from prior research indicates that: externals preferred chance situations over skill situations (Feather, 1967); internals actively seek information relevant to problem solving (Davies & Phares,1967). Internals tend to retain, learn, remember and attend to more information, especially when the information is related to personal future goals (Long, 1979). Internals are more active information processors and are able to better use previous information in decision-making tasks (Pines, 1973).. Internals also believe that reinforcements are contingent upon their own behavior, capacities, or attributes. Externals believe that reinforcements are not under their personal control but rather are under the control of powerful others, luck, chance and fate (Rotter, 1966; Joe,1971). Internals are generally more concerned with their abilities and their failure (Efran, 1964). They seem to have greater need for independence and are resistive to subtle attempts at influence (Crowe & Liverant, 1963; Strickland, 1963).

Statement of Problem

Prior research has found that color-coding to be an important instructional variable in facilitating student achievement (Dwyer; 1978, 1987); its instructional effect on two learning stages (Internals and Externals) constituted the focus of this study. Since students processing the different learning styles perceive and process information differently, different levels of visualization (black and white and color coded) were used in order to determine the most effective level in facilitating achievement for both learning styles. Specifically, the purpose of

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this study was to (a) examine the instructional effectiveness of two types of visualized instruction in facilitating student achievement for students identified as possessing different styles of learning (Internals and Externals); (b) determine whether an interaction exists between types of learning style and instructional treatment, and (c) determine whether specific instructional treatments were equally effective in facilitating the achievement of I-E students on specific educational objectives.

Methods and Procedures

One hundred and seven college students were classified as external, neutral or internal locus of control based on their scores on the Rotter (1966) Internal-External Locus of Control Scale. Students were identified as external, neutral or internal by separating the performance are one half standard deviation above and below the mean. This process resulted in thirty-six students being identified as externals, fifty-five as neutral and twenty -six as internals. The instructional content employed in the study was the anatomy and functions of the human heart during the diastolic and systolic phases. The instructional unit also contained 19 visuals positioned as a result of item analysis. The instructional booklet included one page of directions and twenty pages of concepts and functions of the heart integrated by prose text with accompanying visualization. Directions on the first page of the booklet indicated to the students that the materials were part of an investigation to study the relative effectiveness of visual illustrations accompanying printed instructions and that there was no time limit. For purposes of this investigation, six color categories and black were used to code the heart concepts (See Table 1). Printer's ink colors selected were from Pantone Matching Systems.

The six colors were: red (Pantone---warm red, blue (Pantone ----process blue), green (Pantone--green), purple (Pantone--No. 227), brown (Pantone--No. 471) and gold (Pantone--No. 124). The black (Pantone--black) was used for all the non-color coded design elements within the color coded materials and for all the design elements within the black/white material.

This scheme of color coding application to central concept sequences and the lack of the color code in peripheral sequences insured that the color code: (1) was used only to emphasize the central concept being presented; (2) was used to structure a large number of heart concepts into smaller category groups; (3) was used to differentiate dissimilar concepts; and (4) was used to contextually (physical form) and semantically (associative value) relate similar concepts or functions. The scheme of color coding application to the instructional sequence also insured that: (1) peripheral learning was not emphasized; (2) a contexual color cue was not continuously conditioned; and (3) an association was not based purely on semantics.

Thus the black/white instruction: (1) could not visually emphasize central from peripheral concepts within the prose text; (2) could not visually structure a large number of heart concepts into smaller category groups; (3) could not visually differentiate dissimilar concepts; and (4) could not contextually (physical form) relate similar concepts or functions. The black/white instruction, while having similar contextual cues (word labels, arrows, and shaded areas), relied primarily on the learner's associative ability to categorize and relate word meanings.

Treatment 1. Students in this treatment received the 1800 word instructional unit complemented by the 19 black and white visuals.

Treatment 2. Students in this treatment received the identical prose instructions and visuals as did students in Treatment 1; however, their (19) visuals were coded according to the scheme presented in Table 1.

Table 1. Scheme of Color Coding Application to Instruction and Test Materials.

Color Code Heart Concepts[a]
Red right auricle; left auricle; epicardium; auricles; diastolic; lowest pressure; contract; relaxation; arrows[b]
Blue right ventricle; left ventricle; myocardium; ventricles; systolic; greatest pressure; pressure is greatest; contract; contraction; arrows[c]; arrows[d]
Green tricuspid value; mitral value; endocardium; apex; valves; opened; opens; partially open; partially closed; closed; closure; hashing and brackets[e]
Purple pulomary value; aortic value; semi-lunar valves; valves; tendons; open; close; closed
Blue superior vena cacva; inferior vena cava; pulomary veins; pericardium; vena cavas
Gold pulomary artery; aorta, aortic artery; septum, arteries
Black body; lungs; heart[f]; arrows[g]; misc.[h]

Red	ectoderm; venic value; arteries
Blue	----
Green	Vascular space; parasympathetic
Purple	semi-lunar chamber; semi-lunar value
Brown	pulomary vein; inferior vena cavas; superior vena cavas; sympathetic; veins, extoxin
Gold	aortic base; aortas; pulomaryarteries; ectocardium; sympatric; cardiac artery; septic value
Black	none of these; misc.[h]

[a] Most colored heart concepts had an identical color arrow(s) extending from the concept word to the concept visualized; some colored heart concepts had identical colored areas representing visually the concept word.

[b] Arrows were designed to visually illustrate auricle contraction.

[c] Arrows were designed to visually ilustrate ventricle contraction.

[d] Arrows were designed to visually illustrate the first and second contraction during the systolic phase.

[e] Hashing and brackets were designed to visually illustrate the area representing the concept apex.

[f] The heart was visually represented by a simple line drawing.

[g] Arrows were designed to visually illustrate blood flow and blood pressure against the heart values.

[h] Some correct and distracter items were black in the comprehension task.

Criterion Measures

Rotter's Internal-External Locus of Control Scale was used to identify the degree of externality among students participating in this study. The scale consists of twenty-nine fixed-choice items, six of which are filter items. Immediately upon completion of these respective instructional modules, each student completed four individual criterion measures. Following is a brief description of each.

Drawing Test

The drawing test assesses the students' ability to construct the heart in its proper context. The students will draw a representation of the heart and label the parts with numbers that correspond to a list of 20 parts given the test, for example, the epicardium, aortic valve, septum, and pulmonary veins. The test was evaluated for correct visual placement of the parts.

Identification Test

This test evaluates the students' ability to identify the parts of the heart from supplied drawings of the heart with four or five letter labels pointing to various areas of the heart. The purpose of the test was to measure the students' use of visual cue to discriminate different structures of the heart and connect proper names of the heart with the location of the part.

Terminology

The test was designed to measure the students' knowledge of facts, terms and definitions. The objectives measured can be generalized to any content area where basic elements are a prerequisite to the learning of concepts, rules, and principles.

Comprehension Test

This test measures the students' ability to evaluate the functions and the position of certain parts at a particular time when the heart is functioning. The student must understand the parts of the heart, their function, and the simultaneous process that takes place during the systolic and diastolic phases. The purpose of the test is to measure understanding in order for the student to explain some other event.

Total Criterion Test

The items (80) given in the drawing, identification, terminology, and comprehension tests were combined to give a total achievement score.

Results and Discussion

The 2x3 analysis of variance design was analyzed for its main effects and interactions. The main effects were the locus of control and color coding. Table 2 illustrates the number of students in each comparison along with there respective mean achievement scores and standard deviations on the total criterion test and Internal-External Locus of Control Scale for the different comparisons.

Results indicated that a significant main effect existed in favor of the color-coded treatment on the total ($F=11.01$, $df=1/111 p.<.05$) identification ($F=4.66, df_{-}{}^{1}/111$, p. (.05) and the drawing ($F=45.3$, $^{1}/111$, p. $<.05$) criterion measures. Insignificant differences between the black and white and color coded treatments were found to exist in the terminology and comphrehesnion tests. Insignificant differences were found to exist among levels of Locus of Control (high, medium, low) ($F=1.41$, $df=^{2}/111$, $p.>.05$ and color coding and Locus of Control ($F=58$, $df=^{2}/11$, $p.> .05$. The Locus of Control variable did not have a significant main effect in facilitating student achievement in terms of their ability to generalize and perform on the total criterion test. In general, the Locus of Control variable dichotomizes individuals who take responsibility for their own meaning and those who do not. These insignificant achievement results may be partially examined by the fact that college students were used as the experimental population. Although they were divided into internals and externals based on their performance on the Rotter I-E Scale, the dichotomy itself may have been artificial. Since most college students have already exhibited internal characteristics (being of the belief that industrious behavior-study will lead to success) the division (one half standard deviation above and below the grand mean) many separated internals into two groups called internals and externals. Under these circumstances it was unrealistic to expect significant differences to reveal themselves in

terms of increased performance. Another possible expectation for the inability of the different levels of locus of control to perform differentially on the total criterion test might be the first that students did not realize that the colored illustrations they were receiving were colored-coded according to a specific rationale (system). Had they been aware of the system their performance may have improved significantly.

Table 2. Means and Standard Deviations for all Comparisons

	N	M	SD
Treatment 1	58	59.85	12.27
Treatment 2	59	50.42	14.56
Locus of Control			
Low	36	54.75	13.01
Medium	55	53.55	15.84
High	26	58.85	11.84
Locus of Control (B & W and Color Coding)			
Color/Low	20	58.4	11.81
Color/Medium	26	60.00	13.10
Color/High	12	61.92	11.88
B & W Low	16	50.18	13.36
B & W Medium	29	47.75	16.04
B & W High	14	56.21	11.57

The significant main effect indicating that students who received the color coded instructional treatment achieved significantly higher scores on the identification, drawing and total criterion test than did those students who received the black and white indicates that color remains to be a important instructional variable in improving student achievement. The findings of this study emphasize the importance of the interrelatedness of variables associated with learning and the effective use of visualization in the teaching learning process. It verifies the fact that visualization in the instructional process functions not as an isolated phenomena, but an interrelated constituent process operating at varying levels of complexity--the elements of which acquire significance only in the context in which they are used. The explanations introduced and their implications should be carefully evaluated by instructional designers and researchers for further research into the more effective design of visualized instruction.

Note: This Presentation was based upon an article submitted to the *International Journal of Instructional Media*.

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